MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2019/2020

ERT2016 – ENGINEERING MECHANICS

(RE)

4 MARCH 2020

9.00 a.m.– 11.00 a.m.

(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of 7 pages including the cover page.
2. This paper is divided into **Sections A and B**. Choose TWO questions to answer in each section.
3. The distribution of the marks for each question is given.
4. Please write all your answers in the answer booklet provided. All necessary workings **MUST** be shown.

Section A
Question 1

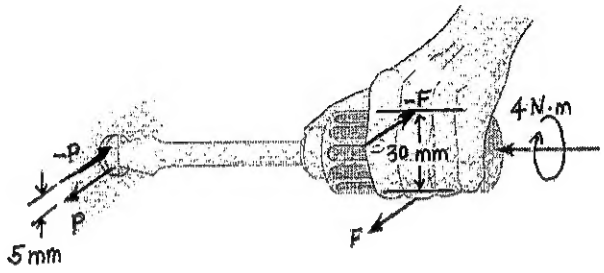

Figure 1

(a) A twist of 4Nm is applied to the handle of the screwdriver. The distance between force $\vec{P}$ and $-\vec{P}$ is 5mm while it is 30mm for $\vec{F}$ and $-\vec{F}$. Define moment and calculate

i) the force $\vec{P}$ exerted on the blade. [5 marks]

ii) the force $\vec{F}$ exerted on the handle [3 marks]

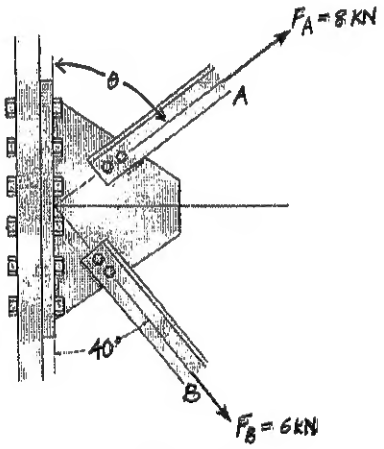

Figure 2

b-i) The plate is subjected to the two forces at A and B as shown in Figure 2. If, $\theta = 60^{\circ}$, determine the magnitude of the resultant of these two forces and its direction measure clockwise from the horizontal. [10 marks]

b-ii) Determine the angle θ so that the resultant force of $\overrightarrow{F_A}$ and $\overrightarrow{F_B}$ is directed horizontally to the right. [7 marks]

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Question 2

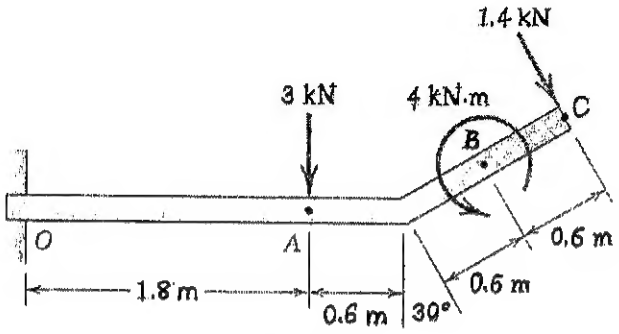

Figure 3

a) The uniform beam has a mass of 50kg per meter of length. The force loads shown lie in a vertical plane. Calculate

i) the reactions F_x and F_y at the support O. [10 marks]

ii) The moment at the support O. [7 marks]

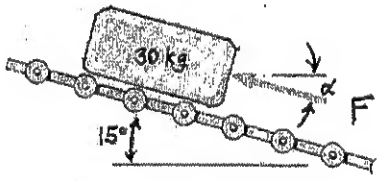

Figure 4

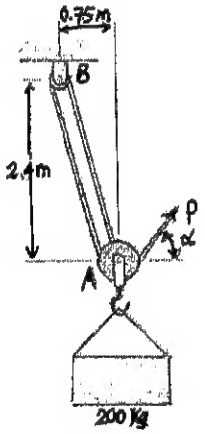

Figure 5

b) Figure 4 shows the 30-kg package is in equilibrium with the force $\boldsymbol{F}$ acting on the system. Note that the force exerted by the roller on the package is perpendicular to the line. Figure 5 shows a 200-kg crate is to be supported by the rope-and-pulley arrangement shown. The force $\boldsymbol{P}$ is to be exerted on the free end of the rope to maintain equilibrium. (Hint: The tension in the rope is the same on each side of a simple pulley). For both systems, without solving the problem, draw the free-body diagram to depict the equilibrium forces. [8 marks]

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Question 3

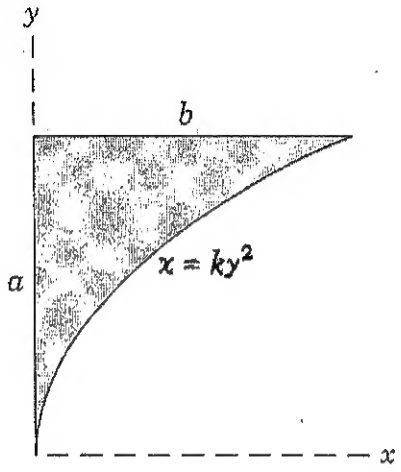

Figure 6

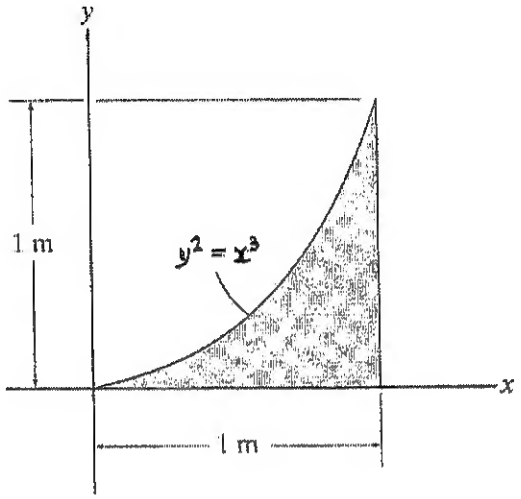

Figure 7

a) Refer to Figure 6. Determine the coordinates of the centroid of the shaded area.
[13 marks]

b) Refer to Figure 7. Determine the moment of inertia of the area about the x axis.
[12 marks]

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Section 2

Question 4

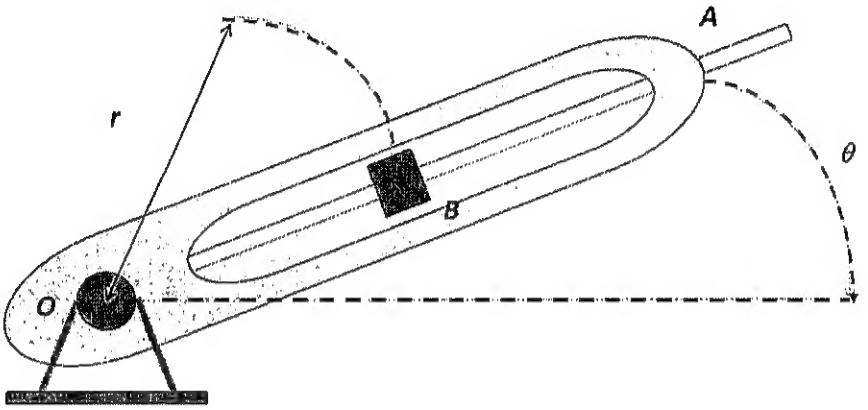

Figure 8

Rotation of the radially slotted arm is governed by $\theta = 0.2t + 0.02t^3$.

Simultaneously, the power screw in the arm engages the slider B and controls its distance from O according to $r = 0.2 + 0.04t^2$. In the other words, when the slotted arm moves in angular motion, the slider B is able to move along the axis *OA*.

Calculate the magnitude of the

a) velocity(v_r and v_θ) [18 marks]

b) acceleration(a_r and a_θ) [7 marks]

of the slider for the distance when t = 3s. θ is in radians, r is in meters and t is in seconds.

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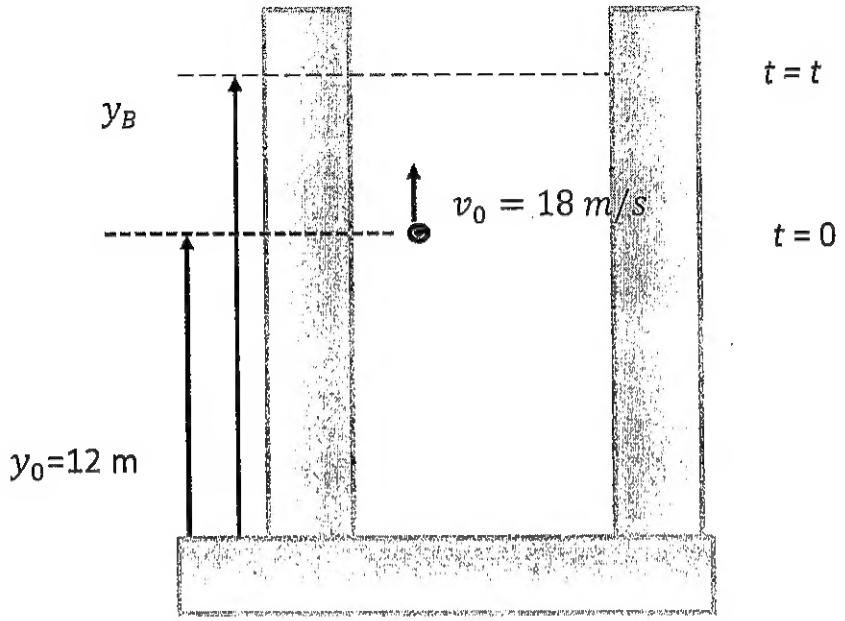
Question 5



(a) In Figure 9, a ball is thrown vertically from 12 m level in elevator shaft with initial velocity of 18 m/s. At the same instant, open-platform elevator passes 5 m level moving upward at 2 m/s. Determine

i) when and where the ball will hit the elevator [4 marks]

ii) relative velocity of ball and elevator at contact [5 marks]

b) The acceleration of a particle is defined by the relation $a = 3e^{-0.2t}$, where a and t are expressed in m/s^2 and seconds, respectively. Knowing that $x = 0$, and $v = 0$ at $t = 0$, determine

i) the velocity of the particle when $t = 0.5$s. [8 marks]

ii) the position of the particle when $t = 0.5$s. [8 marks]

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Question 6

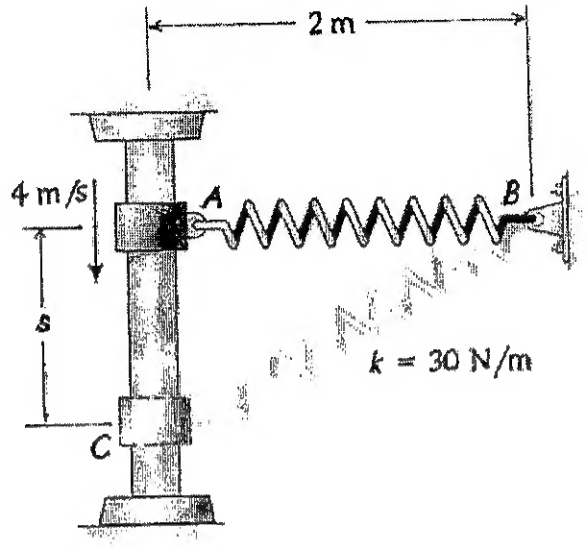

Figure 10

a) The 2 kg collar as shown in Figure 10 is moving down with the velocity of 4 m/s at A. The spring constant is 30 N/m. The unstretched length of the spring is 1m. Determine the velocity of the collar when s = 1 m using *conservation of energy* method. [9 marks]

b-i) Define in engineering context, the word "Impulse". [2 marks]

ii) Ali, who has a mass of 50.0 kg, is riding at 90.0 km/hr in her car when she must suddenly slam on the brakes to avoid hitting a monkey crossing the highway. She strikes the air bag, that brings her body to a stop in 0.500 s. What average force does the seat belt exert on her? [3 marks]

iii) If Ali had not been wearing his seat belt and not had an air bag, then the windshield would have stopped his head in 0.002 s. What average force would the windshield have exerted on him? Comment on the impact of the force. [5 marks]

c) A hammer and punch is used by a surgeon when inserting a hip implant. To better understand this process, an instrumented implant is inserted into a fixed replicate femur. The upward resisting force from the replicate femur on the hip implant can be neglected, and the impact force from the punch can be approximated by a function,

$$F(t) = 35000sin\left(\frac{2\pi t}{0.004}\right) \text{N}$$

Determine the speed of the implant after impact. [6 marks]

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